A PHOTOCHEMICAL METHOD FOR SEPARATING THE OXYGEN ISOTOPES

BY

ROBERT FRANKLIN McCUNE

A.B., Manchester College, 1937

M.S., University of Illinois, 1939

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN
PHYSICS IN THE GRADUATE SCHOOL OF
THE UNIVERSITY OF ILLINOIS, 1941

URBANA, ILLINOIS

1941

A PHOTOCHEMICAL METHOD FOR SEPARATING THE OXYGEN ISOTOPES

BY
ROBERT FRANKLIN McCUNE
A.B., Manchester College, 1937
M.S., University of Illinois, 1939

AN ABSTRACT OF A THESIS
SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN
PHYSICS IN THE GRADUATE SCHOOL OF
THE UNIVERSITY OF ILLINOIS, 1941

URBANA, ILLINOIS
1941

ACKNOWLEDGMENT

The author wishes to express his appreciation to Professor G. M. Almy for encouragement, suggestions and assistance while directing this research project.

A PHOTOCHEMICAL METHOD FOR SEPARATING THE OXYGEN ISOTOPES

When a chemical reaction following the selective excitation or dissociation of molecules is such that the end products of the reaction have, for at least one of the elements, a changed relative abundance of its isotopes, then this process may be called a photochemical method of separating the isotopes. The selective excitation of the molecules may be accomplished (a) if a strong sharp atomic emission line of an element coincides with an absorption frequency of a particular isotopic molecule, (b) if a suitable filter containing the same material used in the reaction vessel is used with incident continuous radiation.

The radiation from an aluminum spark after passing through 2.5 cm of air and a 2 mm quartz window was used to produce ozone, which was then isolated by condensation and fractional distillation. This limits the radiation to wavelengths greater than about 1800 Å.

Calculations show that there are two close coincidences ($\triangle \nu < 0.5 \pm 2\text{-}3\ cm^{-1}$) between strong aluminum lines near 1860 Å and band lines of the isotopic molecule $O^{16}O^{18}$. No band line of an O^{16}_2 molecule is closer than 6.0 cm^{-1} to an aluminum line which appears with intensity above background in the spectrum of the aluminum spark in air. If only $O^{16}O^{18}$ molecules were excited then the resulting ozone would be 17% O^{18}. The natural value is 0.2% O^{18}. Actually it will be much less due to the weak continuum which is also present.

According to a calculation for a suitable filter of oxygen the ozone produced by a uniform continuum would contain 1.34% O^{18}. It is believed that the filter in the above experimental arrangement approximates this suitable filter.

In a typical run of 2.5 hours oxygen containing by analysis 0.013% ozone was produced, from which 28 cc of ozone, at standard conditions, was isolated. Some ozone was converted to CO_2 and photographs of the (0,2) Angstrom band of CO

were made. The $C^{12}O^{18}$ band was not found on the plate. Neither was the $C^{13}O^{16}$ band, which should be present with 1% of the intensity of the $C^{12}O^{16}$ band, found; hence the test was not sensitive enough to detect a relative abundance of 1%. A mass spectrometer determination will be necessary to measure the actual relative abundance.

VITA

Robert Franklin McCune was born August 23, 1915 in Muncie, Indiana. He attended the public schools of Mt. Morris, Illinois and Harrison Township, Kitchel, Indiana. In 1937 he obtained the degree of Bachelor of Arts from Manchester College, North Manchester, Indiana. From 1937 to 1941 he has been a part-time teaching assistant at the University of Illinois. For the year 1940-41 he has been a University Fellow in Physics. In February 1939 the degree of Master of Science was received from the University of Illinois.

Digitized by the Internet Archive
in 2026

https://archive.org/details/IA41549818_0034